DEPARTMENT OF AGRICULTURE AND STOCK.

The CANE GROWERS' QUARTERLY BULLETIN

ISSUED BY

BUREAU OF SUGAR EXPERIMENT STATIONS

BRISBANE, QUEENSLAND.

VOL. IV. No. 1. 1 JULY, 1936.

Contents.

Registered at the G.P.O., Brisbane, for transmission by Post as a Periodical.

BUREAU OF SUGAR EXPERIMENT STATIONS
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ISSUED BY DIRECTION OF THE
HON. F. W. BULCOCK, MINISTER
FOR AGRICULTURE AND STOCK

1 JULY, 1936

DAVID WHYTE, GOVERNMENT PRINTER, BRISBANE

ERRATUM.

HOW FREQUENTLY DO GIANT TOADS PRODUCE EGGS?—*For* 36 *read* 25.

CONTENTS

The
Cane Growers' Quarterly
—Bulletin—

Vol. IV | 1 JULY, 1936 | No. 1

"Humus"—What Is It?

By N. J. King.

THROUGHOUT the literature of agriculture from all parts of the world the word "humus" is conspicuous. In seeking a definition we find that "humus" is described as "the somewhat indefinite nitrogenous and carbonaceous material resulting from the decay of plants." When plant remains are added to the soil some of the constituents tend to undergo rapid decomposition. This decomposition is the result of the microscopic population of the soil, which utilizes the material as food. The speed of the decomposition depends on the nature of the plant residues and on the type of soil. Other factors such as temperature and moisture greatly influence the rotting-down of the material also.

The partially decomposed material forms a vague and indefinite group of substances to which has been given the name "humus." It has important physical effects on the soil and possesses a number of properties not usually shown by undecomposed plant residues.

Firstly it causes the soil to become "puffed up," and so leads to an increase in the pore space in the soil. This results in a marked improvement in tilth and general physical condition; secondly, it increases the moisture-holding capacity of the soil, since humus has an enormous capacity for absorbing water as compared with the soil minerals; thirdly, although humus is essentially transitional, it has a certain degree of permanency and only slowly disappears from the soil. It disappears more rapidly in tropical than in temperate regions, and more quickly in sandy soils than in loams and clays; finally, humus is rich in nitrogen, which is now universally acknowledged by farmers as an essential factor in cane growth.

In certain European countries where intensive farming is necessary, the utilization of farmyard manure is the general rule, but the production of soil humus by this means on cane farms could not, for obvious reasons, be considered. The canegrower, therefore, grows green crops to be ploughed in, and in some cases utilizes plant residues in the form of cane trash in an attempt to improve his soil. The value of these practices may be considered as follows:—

It will be readily admitted that an improvement in soil tilth is always desirable, and that an increase in moisture-holding capacity would be welcomed on all except the badly-drained farms. Likewise a supply of nitrogen per medium of humus would constitute a saving in fertilizer outlay. If these three objects can be gained by increasing the humus content of the soil, then the end justifies the means employed.

In the growing of a green manure crop (Poona pea, Mauritius bean, cowpea, &c.) advantage is taken of the fact that these crops belong to a certain class of plants known as legumes. Legumes have the property of being able to assimilate nitrogen from the atmosphere through the co-operation of bacteria which make their home in the nodules on the plant roots. It is recognised, therefore, that such plants when ploughed in are enriching the soil with so much nitrogen which they have taken from the air. This property is not possessed by sugar-cane, maize, sorghum, and other plants, which return to the soil only such nitrogen as they have taken from it.

A good crop of Poona pea will produce 15 tons of green matter to the acre, and the ploughing in of this mass of material must, when rotted, undoubtedly improve the mechanical condition of the soil. The amount of nitrogen thus added to the soil would be equivalent to approximately 700 lb. of sulphate of ammonia to the acre. The ploughing in of a 15-ton crop of maize would apparently have the same effect on the soil tilth, but other factors operate against it. The prime requirement for rapid and complete decomposition of a green crop—apart from temperature and moisture—is a good nitrogen supply. Decomposition proceeds by means of bacteria and fungi, and a balanced food supply of nitrogen and carbonaceous material is essential for the working of these microscopic labourers. In the case of Poona pea and other legumes the balanced ration is present, but with other crops or a body of trash the nitrogen supply is too low, and the rate of decomposition is retarded. There are two methods of speeding up the rotting of trash—(1) To sow a green manure crop (such as Poona pea) as soon as the trash is ploughed in. This, when ploughed in, in turn, will supply the nitrogen for the rotting of the trash as well as itself; (2) to broadcast sulphate of ammonia on the trash before ploughing in, and thus ensure the necessary food for the bacteria. The method adopted will, of course, be decided by the particular farm or plantation practice.

No doubt many farmers have seen the result of ploughing in trash with no subsequent attempt to supply nitrogen to the soil for decomposition. The writer has observed cases where trash has remained unrotted for twelve months after turning in, only because no green crop was grown, to be ploughed under and assist in the process.

The effect on numbers of soil micro-organisms of ploughing in plant residues is shown by the following figures. Recently one of the Bureau pathologists carried out an investigation on a block on the Bundaberg Experiment Station which is being used as a trash experiment. One portion of the block has been farmed according to standard practice, while the other portion has had all trash ploughed in since 1932. The decomposition of the 1935 trash and the subsequent Poona pea crop were practically complete when the counts were made.

—	Bacteria and Actinomyces.	Fungi.
Trash Plot	108,120,000	2,400,000
No Trash Plot	14,530,000	550,000

These figures are per gram of soil.

It should always be kept in mind that humus affords energy to numerous micro-organisms, and is gradually converted by them into simple substances appropriate for plant nutrition. We may look upon its constituents as taking part in a perpetual cycle—in one stage nourishing the growing plant and storing up the energy of sunlight; in the other stage nourishing micro-organisms and liberating energy and plant foods.

Sometimes humus is lost, sometimes worn out, and at other times destroyed. Rains and floods will often wash humus away from hillsides. Micro-organisms will use it up in the process of making soluble compounds, and it is destroyed by oxidation and by fires. Any intensive method of cultivation increases oxidation, thereby reducing the humus content unless provision is made to replenish the supply by ploughing in more green crops or trash.

Temperature is a very important factor in humus formation and destruction. Humus will be formed wherever conditions of temperature and moisture allow the growth of crops and the survival of micro-organisms in the soil; and humus will be destroyed by micro-organisms under exactly the same conditions. But as the destruction of organic matter is relatively proportional to the temperature we find that two zones can be classified—(1) In which humus will accumulate: here the conditions are more favourable to formation than to destruction, and the temperatures vary between zero and 77 degrees F.; (2) in which humus is destroyed more rapidly than it is formed (assuming that adequate air and moisture are available). This occurs at temperatures above 77 degrees F. This is shown diagrammatically in Fig. 1. Here

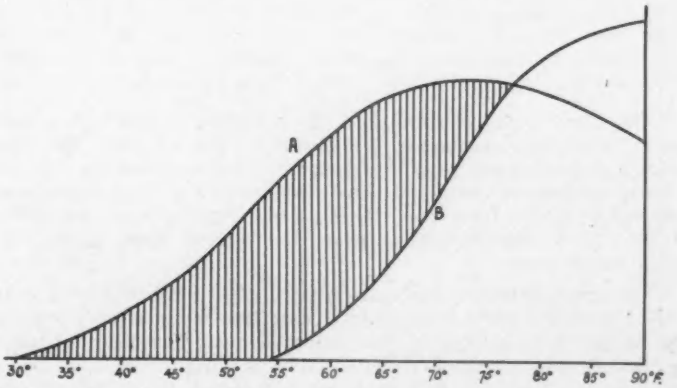

FIG. 1.—Curves showing the relationship between temperature and (A) rate of humus accumulation, and (B) rate of humus decomposition. It will be noted that temperatures experienced in the Queensland cane areas lie on those portions of the curve where rates of decomposition are high.

the base line records temperature, and the perpendicular line represents humus formation or loss. The curved line A represents humus formation at different temperatures, and the line B shows humus destruction. The shaded area is therefore the zone of humus accumulation, wherein humus is formed more rapidly than it is destroyed.

The following question is often asked by farmers on the red volcanic soils. Since we already have good tilth, and can supply nitrogen conveniently from a bag of sulphate of ammonia, why go to all this trouble to provide humus? Apart from the argument of increasing the moisture-holding cacapity of the soil, the following convincing reason may be given:—Recent work in the Brisbane laboratories of the Bureau has shown that the addition of trash to three of Queensland's major cane-producing soil types has resulted after twelve months decomposition in large increases in the amounts of available plant foods in the soil. The process of decomposition of organic matter has evidently a weathering effect on the soil particles, thus transforming insoluble compounds into an available form. An extremely important feature of this same work is that the trash treatment of the soil decreased the soil acidity, thus disproving the popular theory that organic matter would make the soil more acid.

Army Worm Outbreaks.

DURING the period January-March of this year, reports of army worm outbreaks were received from almost every canegrowing district. While it must be admitted that a good deal of loss was caused on pasture lands and in fodder crops, dairymen in particular being heavy losers, the aggregate losses in canefields were negligible.

Nevertheless, a considerable degree of alarm was manifested by canefarmers and for their guidance and reassurance prompt steps were taken to reprint in the country Press the article on army worms and their control which was published in the Quarterly Bulletin for 1st October, 1933 (page 38). The incident serves to emphasise the desirability of canegrowers keeping their files of the Quarterly Bulletin complete and handy so that they may readily refer to them when the necessity arises.

The army worm concerned in the recent outbreak was a different species from that described by Mr. Mungomery in October, 1933, but the general characteristics and the methods recommended for the control of both species are essentially the same. In Fig. 2 is reproduced an illustration taken from the "Queensland Agricultural Journal" for 1st May, 1936; this illustration shows the various stages in the life of a typical army worm.

The army worm is widely distributed and in South Africa is known as the "mystery worm," this name being due to its sudden appearance from apparently nowhere. The caterpillar or "worm" hatches from eggs laid by an inconspicuous moth which is a night flier, and, therefore, rarely seen. They are not, as is often thought, the larvæ of common white or yellowish butterflies which are sometimes noticed in flight a short time before army worm outbreaks.

Most canefarmers will have observed that the recent outbreaks occurred in grass land surrounding the cane or in grassy fallow blocks within the farm. These caterpillars feed chiefly upon the natural grasses and "grassy" fodder crops, such as Sudan grass, sorghum, saccaline, panicum, &c., but in the case of the latter show a decided preference for small young crops. Leguminous crops seem to attract them but little, and it is a common sight to see the caterpillars proceeding through

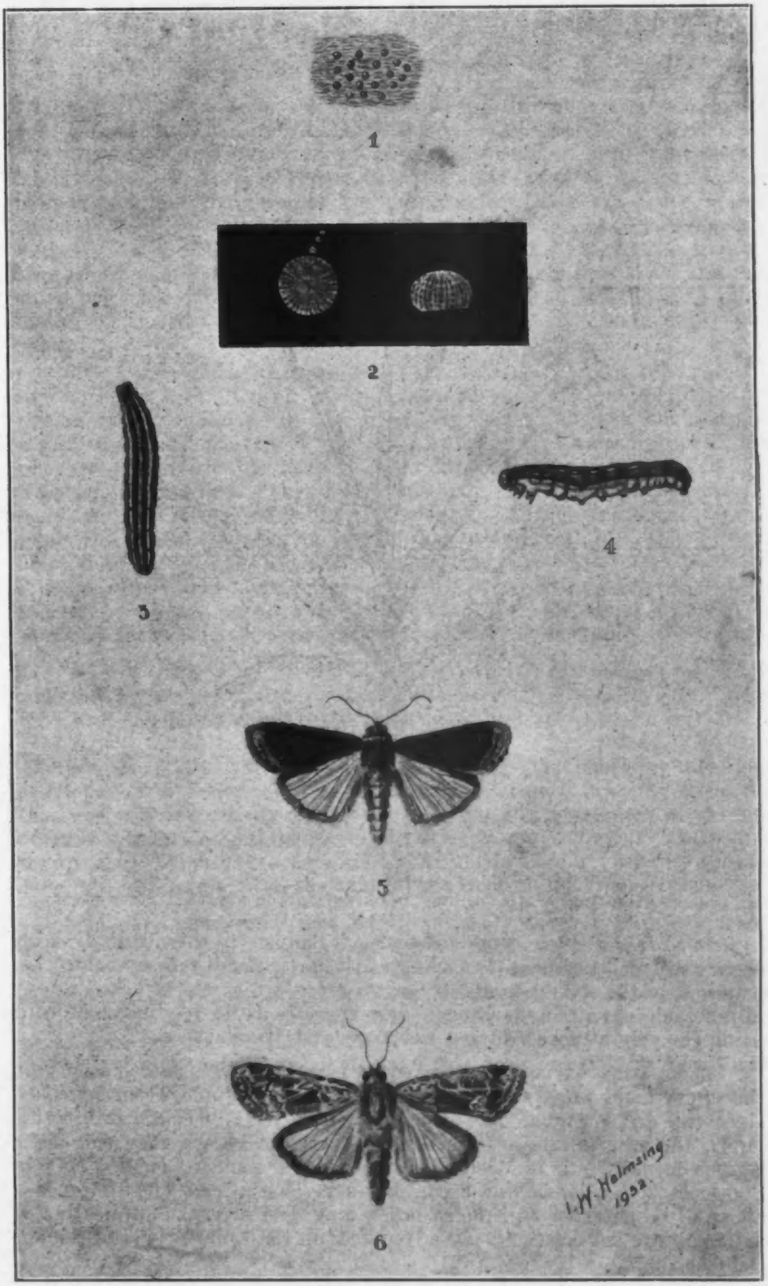

FIG. 2.—Illustrating the various stages in the life of a typical army worm.

lucerne and green manure crops, but eating only the grass which happens to be present.

Fig. 3.—Illustrating typical army worm damage on a young ratoon shoot.

In so far as sugar cane is concerned, damage to this plant by army worms is usually restricted to small cane, particularly ratoons, which are attacked in the spring months. Grown crops are rarely attacked to any appreciable extent, and consequently there is little likelihood of cane being severely attacked during February and March.

These army worms are attacked by many parasites, which soon gain the upper hand when weather conditions are favourable. Consequently, since the first outbreak in sugar districts is usually confined to grass lands, the caterpillars are, as a rule, overcome before they can make serious inroads into canefields. In the spring months, particularly in Southern Queensland cane areas, the army worm can sometimes keep ahead of its parasites and the situation may then need the application of artificial control measures as advocated in the Quarterly Bulletin of October, 1933.

—A.F.B.

Sex Reversal in the Giant Toad.

By R. W. Mungomery.

POSSIBLY no phase of the activities of the Bureau has been followed with such keen interest, particularly by far Northern growers, as the introduction of the colony of giant toads from Hawaii some twelve months ago. It may therefore be a point of further interest to our readers to know that three of the immigrants have lately distinguished themselves by changing their sex. The phenomenon of sex reversal is so rarely heard of by the average individual as to be well nigh incredible and, consequently, we will enlarge a little on the circumstances through which we have definite proof that such a reversal of sex did take place and give some explanation of the manner in which the change is brought about.

As a result of our observation of the habits of the toads in Hawaii, it was resolved to attempt to breed them in captivity. Attempts to do this in other countries had failed, but we were of the opinion that the result could be achieved by the construction of a suitable pond (see photographs in the Quarterly Bulletin for October, 1935, pages 44-45). This decision has been a very happy one, as the success of the experiment has been the means of effecting a distribution of large numbers of young toads in several districts in North Queensland within a few months after the arrival of the original colony. Had this colony been liberated in some centre immediately upon arrival, it would probably have been at least two years before toads could have been recovered in sufficient numbers for wholesale distribution in the other districts.

A few toads were liberated under natural conditions, while the remainder were set out in the specially-constructed pond. These toads have been mustered at intervals and counted and at the beginning of this year it was found that the number of females had increased, while the number of males had decreased, indicating that three males had developed into females. The male toad is usually smaller than the female, but is also readily distinguishable from the female by the presence of raised tubercles on its back, giving it a rough feeling like coarse sandpaper. The backs of both male and female have a "warty" appearance but, apart from this, the skin on the back of the female is smooth.

The particular conditions which induce sex reversal in toads are not very well known, but the actual mechanism by which this change-over to the opposite sex takes place is fairly well understood. The young toads have an internal organ which is known as Bidders organ; as the toads mature this organ degenerates in the case of the female toads but persists in the case of the males. It is virtually a rudimentary ovary and so we might regard the male toad as a suppressed female in which the male factors predominate over the female factors, and so the toad functions as a male. However, due to some as yet unknown cause, in some cases a change in the internal secretions takes place; this brings about a regeneration of Bidders organ and there begins a gradual change from male to female. Bidders organ then functions as an ovary, eggs are developed and deposited and hatch like normal eggs, the only apparent difference being that the number of eggs produced is likely to be much less than that produced by a normal female.

Gumming Disease in the Mulgrave Area.

Officers of the Bureau recently carried out a survey of the quarantine area in the Aloomba-Highleigh district. As a result of the survey it was found that the intensity of the disease had been reduced, due to the ploughing out of the variety S.J. 4 and the passing of plant crops into the less susceptible ratoons. The disease could not be found on two farms previously infected, but an additional infected farm was found just outside the north-east boundary of the quarantine area.

As a result of this finding it has been made necessary to increase the area under quarantine somewhat and in a proclamation dated 16th May, 1936, the following area has been quarantined:—Portions 75, 78, 81, 170, 188E, 188F, 369, 539, 555, 556, and subdivisions 1 and 6 of portion 116, parish of Sophia. (See accompanying map.)

Under the terms of the proclamation the removal of any cane from this area is prohibited except for the purpose of having it milled at the Mulgrave Central Mill. Furthermore, the planting of the varieties S.J. 4 and Clark's Seedling within this area is also prohibited. It should be pointed out that the proclamation specifically prohibits the planting of all sports or variations of Clark's Seedling such as H.Q. 426, Benbow, P.Q. 1, and Gaspari Seedling.

It should be realised that the proclamation of the quarantine area and the imposition of certain conditions have been made in the interests of the growers of North Queensland as a whole, and it is to the interest of all concerned that the conditions be rigidly observed.

A.F.B.

Testing Cane Samples at Experiment Stations.

Some time ago attention was drawn to the conditions which must be observed by canegrowers desirous of having cane sample tests made by our Experiment Stations, for the purpose of determining the state of maturity of their crops, and thus giving an indication of the sequence in which respective blocks should be harvested.

Each sample shall consist of six stalks or 20 lb. of cane, whichever is the greater. Samples of burnt cane will not be accepted in any circumstances. When samples are forwarded over the railway, freights must be paid. By special arrangement with the Railway Department, test canes are consigned at a flat rate of 1s. per bundle. Where facilities for prepayment of freight are not provided, the grower should reimburse the Experiment Station by forwarding 1s. in postage stamps, enclosed in a brief letter advising that the canes have gone forward.

It should not be necessary to point out that the results of our Station tests are never intended for use in checking mill returns; for this purpose they are quite misleading and worthless.

H.W.K.

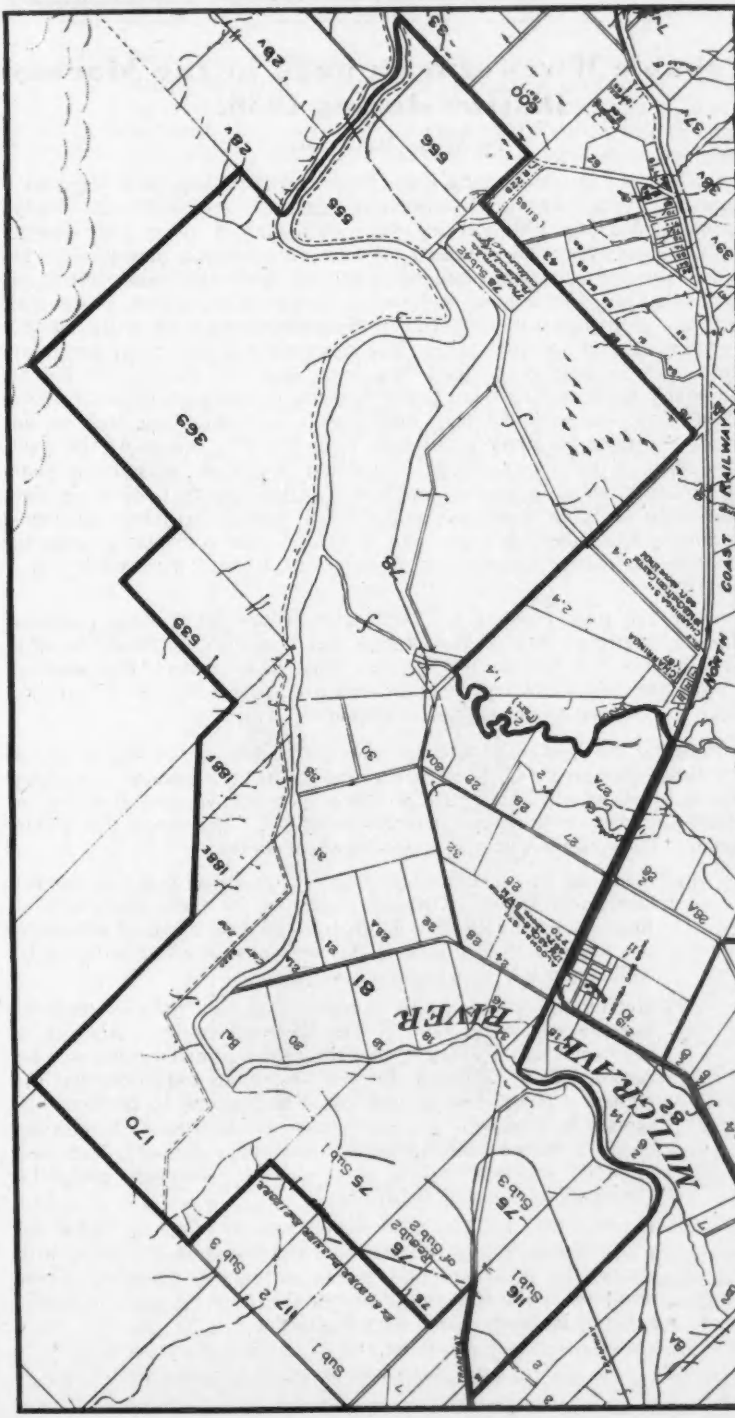

FIG. 4.—Map of the Mulgrave Quarantine Area. (See reference opposite.)

Probable Wireworm damage in the Mackay District during 1936.

By W. A. McDougall.

IN the Mackay district during 1929, 1930, and 1932 fields with "misses" caused by the low land wireworm (*Lacon variabilis*) were fairly plentiful. During 1931, a dry year following a poor wet season, satisfactory strikes were obtained even on exceptionally low lands. In 1933 a number of early plantings suffered from this pest, but it is considered that the winter and early spring rains, which postponed many late plantings until September, were responsible for reducing the wireworm damage for that year. The comparative scarcity of irregular stands of cane during the past two years has still further tended to make many farmers forget the heavy ravages of wireworms during 1928. Unfortunately it is confidently anticipated that this year will be an unkind reminder to many that these pests are not things of the past in the Mackay district. A large proportion of the wet season this year was probably about a month too late to allow its full effect on the establishing of large wireworm populations, but nevertheless the rainfall during December, January and February was sufficiently large to give 1936 the distinct possibility of being the worst "wireworm year" since 1928.

Over the past eight years, with the exception of some isolated instances, drainage of low-lying farms has not been improved to any great extent in the Mackay mill areas. This means that, at this time of the year, the only known preventive measure against wireworm attacks during the coming spring is not available to many.

Perhaps the best way to help improve the situation would be to bring before the notice of farmers some of the more common false ideas on the subject, which, if they are put into operation in an endeavour to control the pest, will do very little more than aggravate the whole position. These useless practices are listed as under:—

(1) Bedding up immediately prior to planting does not reduce wireworm attack. Obviously damage by these pests is confined to poorly-drained land, but the providing of adequate drainage at these times of the year has no effect on already well-established pest populations.

(2) Getting the plants away quickly helps very little in combating the wireworm pest in the Mackay district. Also, in a year such as the present one, the heavy summer rains will be responsible for putting the land in such a condition that all strikes will be slow in any country inclined to be low. It should be pointed out here that the slowness of striking is not a factor contributing to wireworm damage; both are actually independent of one another although partially governed by similar conditions.

(3) Having the land in good order has no effect in reducing wireworm damage. These pests, if present in the field, will attack the sett eyes and shoots at normal planting times irrespective of soil condition at the time or any ordinary cultural methods which may be tried.

(4) There are no chemical or mechanical methods known (or rather which can be vouched for) for economically protecting planted cane setts and growing shoots from wireworm damage. Any expenses incurred by efforts in this direction will probably be merely further debits against wireworms.

(5) The use of manures, such as superphosphate, considered either as a chemical control or as a help in promoting rapid growth, has been found to be futile in combating the low land wireworm in the Mackay district. This statement is based on evidence from plots with adequate checks, laboratory experiments, and field observations in localities where wireworm attacks were quite authentic.

(6) The apparent absence of wireworms during ploughing operations is not a reliable guide as to whether the planting will miss attack by the pests. While only a few wireworms may be seen during ploughing, as much as 50 per cent. of the strike may eventually be damaged. Also wireworms may be seen occasionally in any field, whether high or low, and it is difficult to separate the pest species from harmless ones by a superficial examination. (See Fig. 5.)

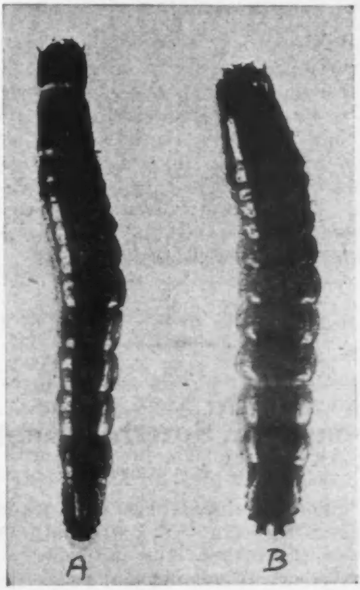

FIG. 5.—Dorsal views of full grown larvae of—(A) *Heteroderes carinatus* Blackburn, × 4; (B) *Lacon variabilis* Cand., × 4.

It has been found that the planting and subsequent inspections of trial setts, in the lowest parts of the fields, is the only satisfactory method of finding out, prior to planting, if wireworm pests are present in doubtful fields. The setts are planted in lots of five and are usually soaked before planting in order to swell the eyes.

Once the farmer has established the fact, either by planting trial setts or from previous experience in "wireworm" years that wireworms are, or probably are, present in certain of his fields, the next step is to try and obtain as satisfactory strikes as possible, but with due regard to farm economics. At this stage the only method of control which can be recommended is the postponement of planting until late September, when the wireworms will have finished feeding. In considering the economics of the situation the farmer might bear in mind the following points:—

(1) Since it may be expected that this will prove a bad wireworm year, farmers would be advised to plant as much high land as possible and to leave known wireworm blocks until a more favourable season or until they can be adequately drained.

(2) If the field is large enough and is divisible into fairly distinct high land and wireworm-infested low land, plant the top portion at normal planting time and the bottom later in the year, or at least arrange that wireworm fields are placed late in the planting programme.

(3) If a field is eaten out it is of little use replanting until late September at the earliest. The same applies to supplying misses in a patchy stand.

It must be emphasised that the above notes are written in order to assist farmers in making decisions in what will very probably be a bad wireworm year for blocks which were not properly drained prior to the wet season. In its early stages the young wireworm requires extremely wet soil conditions in order to survive, although it can later withstand very dry conditions. Therefore, in order to control the pest the land must be bedded up and drained *before the commencement of the rainy season*, so that these excessively wet conditions cannot occur and the wireworm will perish in its early stages. This is the only known satisfactory form of control.

Fiji Disease in South Queensland.

By G. A. CHRISTIE.

FOR many years gumming disease has been responsible for greatly depressed yields in the cane crops of South Queensland, but by substituting disease-resistant canes for the more susceptible varieties the position has been greatly alleviated and losses are rapidly becoming negligible. In order to combat gumming disease it has been necessary to extend the plantings of P.O.J. 2878 and, to a less extent, P.O.J. 2725, two varieties which are susceptible to another important disease—Fiji disease. This disease is more common in the southern districts but is present on a few farms in the Bundaberg-Isis district. The importance of this disease should not be under-estimated, especially in those districts where P.O.J. 2878 holds such promise, and it is in the interest of all canegrowers to assist in its eradication or control.

Fiji disease was first recorded about thirty years ago in the colony from which it takes its name. The industry in these islands was threatened for some years and the crops were seriously affected by the ravages of the disease. It probably originated in New Guinea, and by the interchange of varieties has since spread to Fiji, Australia, and the Philippine Islands.

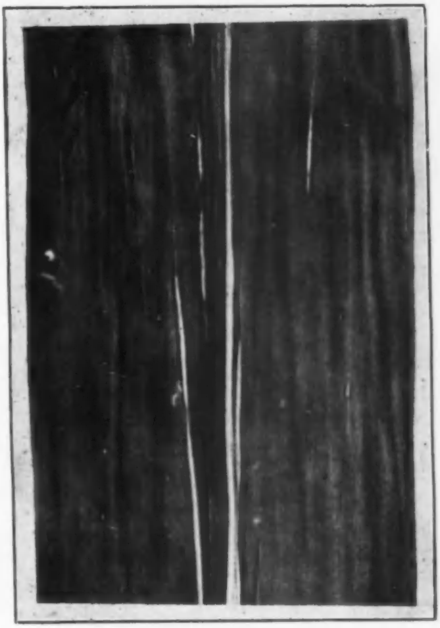

FIG. 6.—Illustrating typical galls on the underside of a diseased leaf.

The earliest symptoms and the outstanding characteristic of the disease is the presence of small yellowish galls which are formed on the under surface of the leaves of diseased cane. These galls may be one to many in number and are usually 1/32 to 1/16 in. in diameter, ranging from $\frac{1}{8}$ in. to 2 in. in length; they are formed by the enlargement of the veins. (See Fig. 6.) In the later stages of the disease the leaves become shortened and erect, very stiff and brittle, and take on a darker green colour. In this stage the cane top looks as though it had been eaten by some animal. When such distortion of the top occurs no further growth is made, the leaves become smaller and smaller and eventually the heart dies. (See Fig. 7.)

When diseased setts are planted they invariably give rise to diseased stools, which in most cases produce no cane but remain a cluster of stunted grass-like shoots; the ratoon stools from diseased plant stools are also of this type. (See Fig. 8.)

Fiji disease is permanent, and no authentic cases of recovery from the disease have been observed. It should be stated that the disease bears a resemblance to other minor troubles, particularly to clustered stool, which was described in the "Quarterly Bulletin" for 1st July,

Fig. 7.—Illustrating the stiff, stunted, and malformed leaves of a well-advanced stage of secondary infection.

1935 (page 8). The question as to whether Fiji disease is present or not can be settled by the presence or absence of the small leaf galls described above.

The investigation of the manner in which the disease is spread from diseased to healthy cane was successfully undertaken by the Bureau some years ago. Contrary to the belief of many growers, it has been established that no soil infection occurs. After ploughing out and killing diseased cane the soil does not remain infective to cane planted at a later date. Nor does cutting diseased and healthy cane alternately

FIG. 8.—The two small grass-like stools in the foreground are the result of ratooning diseased stools. Variety, P.O.J. 2714.

with the same knife produce infection in the healthy cane. The only known means by which Fiji disease is spread is through the feeding activities of the sugar-cane leaf-hopper, a small brownish insect about 1/5 in. in length. After these insects are fed on diseased cane they are capable of infecting any susceptible healthy cane on which they feed. Although cane becomes infected in this way, it does not bear any symptoms for some time after the diseased hoppers have fed on it. Often such diseased cane may appear healthy for some months, and this naturally complicates the job of selecting healthy planting material.

CONTROL.

The methods of control which are recommended, are—

(1) Plant only disease-free cane.

(2) During scarifying and at other times inspect all plant and ratoon cane and dig out any suspicious stools. The leaf-hopper which spreads this disease becomes very scarce during the winter and remains so until about December. Therefore, inspection and digging out of diseased stools should be carried out by November-December.

(3) Restrict ratooning of diseased crops.

(4) The better the conditions for cane growth the better are conditions for the spread of Fiji disease. Therefore, special care is necessary on rich alluvial land or irrigated farms.

(5) Where the disease is well established and spreads rapidly, resistant varieties should be planted. The choice of variety will depend, of course, on what other diseases are present; the best known resistant varieties are P.O.J. 213, P.O.J. 234, Co. 290, Q. 813, H.Q. 285, and Mahona; Korpi and Oramboo are also satisfactorily resistant, while P.O.J. 2379 shows promise in this respect. (For further information see an article on Gumming Resistant Canes in this issue.)

DISTRIBUTION OF THE DISEASE.

During this and the previous season a considerable amount of field survey work has been carried out by Bureau officers, and the results are briefly set out below:—

Bundaberg.

Continued field inspections and digging out of diseased stools, together with supervised plant selection, has reduced the disease considerably at Bingera, though infection is still present and the situation requires close attention. In the Kalkie quarantine area, disease surveys have revealed a reduction in the number of infected farms and in the degree of infection. Nevertheless, the disease is by no means under control on some of the river-flat farms, and some more rigid form of control may become necessary.

Isis.

The disease was reported on several farms some years ago, but with the co-operation of growers and mill officers it was speedily brought under control. Recently it has been found on two neighbouring farms, one of which had carried the disease previously. Owing to the extensive plantings of the very susceptible variety P.O.J. 2878 the present outbreak must be regarded more seriously than the previous one.

Maryborough.

A considerable amount of inspectional work has been done in this district, and since February last year some 350 farms have been inspected at least once. In the Maryborough district proper the disease is present to a considerable degree, and the use of resistant varieties should be more widely adopted. In the Yerra-Antigua section the disease was found on 27 farms in a total of 127 inspected, while 7 in a total of 92 inspected were infected in the Pialba-Takura section. In

both cases, however, the infection amounted to only a few stools per farm, and hence the situation should be readily controlled by the application of a little care on the part of the farmers concerned. At Mount Bauple 2 infected farms were found in the 72 inspected, so that the situation in that locality could readily be controlled.

Moreton.

A survey of a portion of the area showed that Fiji disease was present on 11 farms in 88 inspected. These farms included all that might be suspected of having the disease, and therefore the situation is better than appears at first sight, although definitely serious in view of the value of P.O.J. 2878 in this district. With one exception the disease amounted to a very few stools per farm.

Sugar Exhibit at the South Australian Centennial Exhibition.

A COMPREHENSIVE exhibit, which aimed at providing South Australians with some idea of the sugar industry in its various phases, was despatched to Adelaide for the Centenary Exhibition, which was held from 20th March to 16th May of this year. The accompanying illustrations (Figs. 10 and 11) show the new Centennial Hall which was built especially for the purpose, and the exhibit itself which occupied a prominent position in the hall.

Fig. 10.—Centennial Hall, Adelaide.

The central feature of the display was the model sugar mill which has been used at several previous exhibitions. In its rural setting, it provided a good representation of a typical Queensland cane district, and the complete detail in which the scene was portrayed was a valuable educational feature of the court. To assist in the description a gramophone record had been made, and this was put "on the air" at frequent intervals throughout the day and night. It was found that this talk

held the attention of the visitors very closely, and numerous applications were inevitably received for copies of the pamphlets which had been specially prepared, for the purpose of describing the processes of cane growing and sugar manufacture, as well as presenting facts and information regarding the economics of the industry.

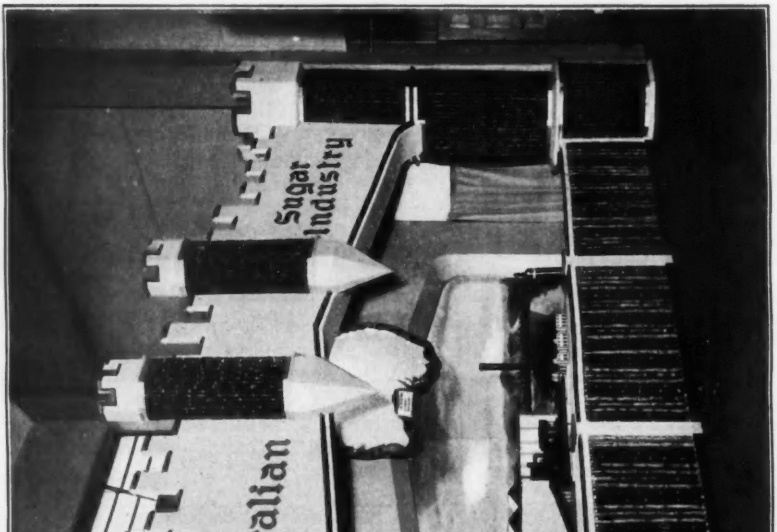

FIG. 11.—A full view of the sugar industry display at the Adelaide Centenary Exhibition.

The display also embraced an exhibit giving some idea of the nature of the research work which is carried out by the Bureau in the control of pests and diseases, the investigation of soil fertility deficiencies, and similar phases of agricultural investigation. In all, over 700,000 visitors attended the Exhibition, and it may be concluded that the display served to correct many erroneous ideas regarding sugar, and presented a faithful estimate of the national importance of the industry.

Gumming Resistant Canes in Southern Queensland.

Their Performance to Date and Possible Future.

By N. J. KING and G. A. CHRISTIE.

IT has been stated previously that the history of the world's sugar industry in recent times is closely identified with the history of its varieties, in relation to their resistance or susceptibility to disease. South Queensland's sugar history is no exception. As early as 1875 Bourbon (a variety introduced from Mauritius) was practically eliminated as a commercial cane by "rust" disease. Rappoe (an introduction from Java) was noticed to be resistant, and the substitution of this variety enabled the industry to survive. During the eighties and nineties this variety, as well as many later importations—Striped Singapore, Daniel Dupont, &c.—became infected with gumming disease, and the industry in the south again approached a critical period. The introduction of D. 1135 from Demerara in 1895 by Messrs. Young Bros. of Fairymead, was responsible for the wholesale planting of this variety in later years, and its partial tolerance to gumming made it the most important variety for the last two decades. This tolerance to gumming was also assisted by the occurrence of periods of acute drought which reduced the spread of the disease in this new variety. At late as 1920 D. 1135 constitued 80 per cent. of the Bundaberg district crop. The severity of gumming during the twenties caused the disappearance of Badila and the decline of D. 1135 to some 27 per cent. of the total by 1931, and the gumming resistant Q. 813, Uba, and Co. canes constitued 32 per cent. By 1933 P.O.J. 213 (introduced by the Bureau from Java in 1922) was being planted on a large scale, and the Bureau had also imported a large number of canes in the endeavour to obtain gum resistant varieties of better quality for the southern area.

By 1933 gum-resistance trials had been completed and stocks of some seven highly-resistant canes of good agricultural promise were available for farm trials. Initial experiments had been harvested on the Bundaberg Experiment Station, but it was desired to try out the canes experimentally on the farmers' own land, under a diversity of soil conditions, before release for commercial growing was made. The success of the above plan is now manifest in the proportion which some of these canes are assuming in the last season's plantings. The climate of the Bundaberg district is eminently suitable for a two-year cropping cycle, and it was doubtless due to the incidence of gum in the previously grown varieties that Bundaberg adopted a one-year cropping programme. The finding of a good standover cane with gumming resistance was therefore a matter of supreme importance, and the performance of the Java Wonder cane—P.O.J. 2878—leaves no doubt that this serious problem has been solved. To date it has displayed the highest degree of gum resistance, excellent vigour of growth, drought resistance to a marked extent, and splendid ratooning qualities. Where standover crops are grown P.O.J. 2878 has not yet been surpassed in that it retains weight over the twenty-four months' period, gives good sugar content early in the second season, and ratoons vigorously from a standover crop. In common with all varieties it has certain shortcomings, but taken on the whole it marks a definite milestone in the

advancement of sugar-cane agriculture in the south. This variety and the six others mentioned above have been used in many of our farm and Station trials, and it is the purpose of this article to summarise these experiments with a view to discussing the performance and possible future of the several canes.

When a trial was arranged on a farmer's land, the Station supplied four new varieties, and the farmer was asked to try these out against his own standard variety without prejudice. All varieties were planted at the same time, with plots arranged on the Latin square so as to give as accurate results as possible, and eliminate error due to soil variation in the block. The trials were fertilized or not according to the farmer's practice on the block, and all were harvested at the same time. In 1933 we planted seven such trials, in 1934 three more were planted, and the complete results from these have been clearly tabulated in the Quarterly Bulletins of October, 1934, January, 1935, October, 1935, and January, 1936. Readers are referred to these numbers for the results. In Fig. 11 are set out the performances of all varieties, including the standards, in the form of a block diagram. This shows the average tonnage of each variety in the several trials, and is a reasonable indication of the relative vigour of these canes under a variety of soil types and climatic conditions.

The above summary involves ten sites and (aggregating plant and ratoon crops) the harvesting of fourteen crops. All ten trials will be harvested again in the coming season; in the meantime, three more trials have been planted in Bundaberg and Maryborough, and at least four are planned for the coming spring. The experiments above cited were set out for the purpose of proving the superiority of gum-resistant canes, but the necessity now arises for the introduction of new canes into the Fiji-diseased districts and, fortunately, some of the above, notably P.O.J. 213, 234, 2379, and Co. 290 are also resistant to Fiji disease. The success of these varieties in the Maryborough and Kalkie Fiji quarantine areas will therefore serve a twofold purpose.

It will be noted that some of the varieties tried in the above experiments have not been released although they compare well with the old standards in yield. For various reasons they have not approached the standard set by Co. 290 and P.O.J. 2878, and on that account it has been considered undesirable to distribute varieties which are only second rate in performance. Some have been eliminated on the grounds of low quality or relative poor vigour, one or two had extremely poor covering power in the interspace, and one cane was thought unsuitable on account of the ease with which eyes were damaged and the resulting bad strike.

The variety Co. 290 was included in every one of the above trials, but the standard cane varied according to the farmer's preference. It is interesting to note, however, that in all trials Co. 290 averaged 38·65 tons per acre and that the standard canes (D. 1135, M. 1900, P.O.J. 213, Q. 813, H.Q. 285, and Q. 1098) averaged only 24·46 tons per acre. The average C.C.S. for the Co. 290 in all experiments was 13·85 as against 13·95 for the standard canes. When one considers that all of these trials were conducted under unirrigated conditions one wonders what the future of the southern district is likely to be. A variety which will top the average of all the previous standard canes by over 14 tons per acre under extremely varied conditions cannot but have a profound influence on the agricultural production of the district.

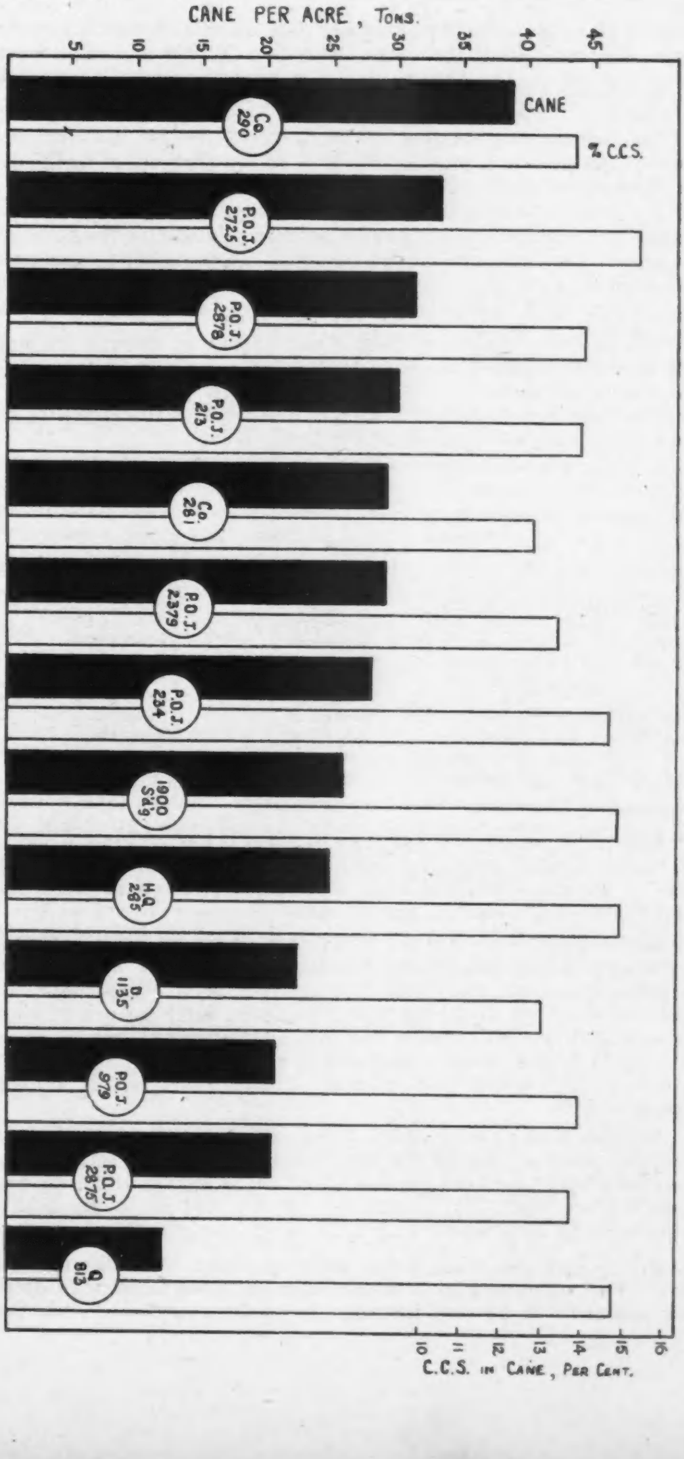

Fig. 11.—The diagram represents the average cane tonnages harvested for the above varieties in all trials to date. The corresponding average c.c.s. figures are also shown.

What P.O.J. 2878 has done for the Isis district it can do in similar degree for the rest of the south; with the Co. 290 and other varieties mentioned above, the future of the southern industry seems assured and the periodic outbreaks of gumming disease a thing of the past.

The outstanding success of P.O.J. 2878 in the Isis district has, however, resulted in a practice which is, to say the least of it, ill-advised. No matter how good the variety, it was never recommended to occupy 100 per cent. of any grower's land. So long as Fiji disease exists in South Queensland it will remain a potential danger to the farmer who has placed "all his eggs in one basket." It is strongly recommended that growers with over 50 per cent. of this variety give a reasonable trial to some Fiji resistant canes—preferably Co. 290 and P.O.J. 213.

Resistance to gumming disease and vigour of growth are not the only desirable features possessed by some of the new varieties. A short table below sets out for each of the old standard canes and for the new varieties used in the above trials their resistance or susceptibility to our three major diseases—gumming, Fiji, and mosaic.

Variety.	Reaction to Disease.		
	Gumming.	Fiji.	Mosaic.
M. 1900 Seedling	Susceptible	Susceptible	Susceptible
D. 1135	Susceptible	Susceptible	Susceptible
Q. 813	Resistant	Resistant	Resistant
H.Q. 285 ..	Susceptible	Resistant	Fairly susceptible
Co. 290	Resistant	Resistant	Moderately susceptible
P.O.J. 213 ..	Resistant	Resistant	Susceptible but tolerant
P.O.J. 234 ..	Resistant	Resistant	Susceptible but tolerant
P.O.J. 2379 ..	Resistant	Resistant	Tolerant
P.O.J. 2725 ..	Resistant	Very susceptible	Resistant
P.O.J. 2878 ..	Resistant	Very susceptible	Resistant

Like all canes the new varieties perform better on certain soil types and under certain conditions than others; as a result of observations made on the above trials and on more recent commercial plantings the following recommendations are offered:—

Red volcanic soil.—P.O.J. 2878 either as spring plant for a stand-over or as February plant for a 17-18 months' crop. Co. 290 as February plant for 17-18 months' crop will produce good sugar early in the season. P.O.J. 234 as spring plant, being an early-maturing cane and recommended on this account for frosted sections of the Woongarra. P.O.J. 2725 is well worth a trial on red volcanics away from the arrowing areas. It thrives best with moist conditions but is subject to frosting.

Reddish sandy forest soils.—P.O.J. 2878 as above. In the case of February plant a frost in the first winter will not do serious damage as no cane will have been formed. Co. 290 as spring or autumn plant depending on local frost conditions. P.O.J. 234 as spring plant for early-maturing cane, and P.O.J. 2725 as autumn plant.

Brown volcanic soil.—P.O.J. 2878 as above. Co. 290 as autumn plant. The vigorous growth of Co. 290 on these moist soils does not allow maturity to develop properly in twelve months. P.O.J. 234 as

above, and P.O.J. 2379 as spring plant. P.O.J. 2725 not recommended as these brown volcanics occur principally near the coast where arrowing is heavy.

River alluvial soils (very wet as on parts of the Maroochy River).—P.O.J. 2878 as standover from spring plant; it is usually too wet for autumn planting on these lands. Co. 290 is not strongly recommended on the very wet farms as rank growth and low c.c.s. may result. More data are required on this point. P.O.J. 234 will contract mosaic badly on river lands, but the trials gave good tonnage and c.c.s.

River alluvial soils (rich types such as at South Bingera and Wallaville but better drained than Maroochy River lands).—P.O.J. 2878 as spring plant for a standover crop. Co. 290 spring plant for frost resistance although the c.c.s. may be low—it is better to use this variety on the poorer blocks. P.O.J. 234 is a valuable cane on account of early maturity; it may contract mosaic badly, but observations have shown that P.O.J. 234 is not greatly affected in growth by mosaic. Co. 290 appears to stand over well on the older alluvials such as Fairymead, and its frost resistance is a valuable factor in this regard.

Each and every one of the varieties mentioned above has been criticised at some time or other by growers, and it is thought desirable at this juncture to give a few brief notes on the canes, showing the individual advantages and drawbacks.

Co. 290.—Much superior to the older Co. canes. Barrel approaches that of D. 1135 in thickness. Very vigorous, excellent stooling, low fibre. Foliage shades ground rapidly—probably best covering variety we have. Resistant to frost, gumming, and Fiji. Leaves susceptible to wind-burn in dry weather, giving the cane a distressed appearance. Reacts very rapidly to rain after dry spell. Yields have surpassed those of all other varieties in a number of farm trials and sugar content has been more than satisfactory except under wet river land conditions. Sticks develop side cracks, but this is not known to be harmful. One case of red-rot reported, and one case of pithy stick, but these appear to be exceptions. Seems to stand over well and it should be remembered that the spring of 1935, when Co. 290 appeared very distressed, was the driest spring on record (with the possible exception of 1902) in Bundaberg. Mid-season maturing and excellent striker.

P.O.J. 2878.—The Java "Wonder Cane." This variety is already well known to most growers. In the Isis district it has rejuvenated the industry and is becoming an important variety in Bundaberg and further south. Highly resistant to gumming and mosaic; very susceptible to Fiji. Needs age for maturity—rarely less than fifteen months in plant crop. The best standover cane for South Queensland. Strong rooting system, upright to a marked degree under strong windy conditions. Tops rather upright—recommend to plant rows not more than 4 feet 6 inches apart. Very vigorous ratooner. Plants do not germinate well in cool weather. Plant always between September and February. Select plants with well-developed eyes. Plants with small flat eyes are very slow to germinate. First class irrigation cane. Susceptible to frost damage but deteriorates only slowly. Good striker if planted in warm weather, but if weather is cool put very light cover on plants. Sometimes prone to produce clustered stool—a freak stool containing upwards of 100 shoots, none of which makes cane—which must not be confused with Fiji disease or any other disease symptom.

P.O.J. 2725.—Has untidy habit of growth in young stages, but rapidly straightens up afterwards. Very resistant to gum and mosaic, but susceptible to Fiji. Does not resist frost. Heavy thick cane with wide leaves. Reputed to be early maturing, but has not been markedly so in Bundaberg. Excellent irrigation cane, but not strongly recommended for very dry lands. Arrows freely on the coast in May-June, so that a poor crop after a dry year could not be stood over in this locality. Most vigorous ratooning cane we have seen. Low fibre. Recommended for February planting. Produces good stool and is excellent striker. Inclined in some years to produce abortive arrows, in which case the top dies and a cluster of shoots sometimes develop from the top of the stick.

P.O.J. 234.—Thin cane of P.O.J. 213 class, necessitating burning prior to harvesting. Definitely early maturing—an advantage on frosted land. Not so vigorous as Co. 290. Resistant to gumming and Fiji disease, but susceptible to mosaic on river lands or other grass-infested farms. Top rather upright not providing a good cover at 4 feet 6 inches interspacing. Good striker and stooler.

P.O.J. 2379.—A cane of medium thickness which has done well on moist farms. (See trial F. M. Schleger.) Resistant to gumming and Fiji and tolerant to mosaic. Good striker and stooler, and vigorous in ratooning. Trash clings rather tightly, which is against green cutting. Principal interest in this cane at present is resistance to Fiji disease.

P.O.J. 2940.—Very erect growth and vigorous under good conditions. Poor striker due to eye damage which occurs easily, only fair stooler. Resistant to gum and mosaic, but very susceptible to Fiji. Does not cover in the interspaces, and would be an expensive cane to cultivate. This cane is extremely susceptible to Downy Mildew disease, contracting it quite readily under dry conditions. In view of its other weak features, therefore, its planting cannot be recommended.

Co. 281.—This cane has not yet been released. Although superior in yield to P.O.J. 234 in trials on J. Young's farm, the c.c.s. was lower, and the extremely upright top makes it an undesirable cane. It does not approach Co. 290 in performance. Resistant to gumming, but fairly susceptible to Fiji disease. A high-fibred variety.

P.O.J. 2883.—A variety on which we have little information to date. Performed well in one spring plant trial, but proved inferior to Co. 290 in tonnage and c.c.s. A thick variety with good growth habit, resistant to gumming and mosaic, but susceptible to Fiji disease. Good striker and stooler. Further trials being planted this year.

P.O.J. 2875.—Fair quality cane, but inferior to P.O.J. 2940 in sugar content. Otherwise all remarks regarding germination and growth of P.O.J. 2940 apply to this variety, although not quite so erect in habit. Cannot be recommended for planting at this juncture.

We have heard many reports regarding the bad striking of not only P.O.J. 2878 but others of the P.O.J. varieties, principally P.O.J. 2714 (when it was grown) and latterly P.O.J. 2725. A little thought suggests a reason for this, apart from cold conditions of planting as mentioned above. The internodes of these canes are, on the average, much longer than the internodes of the older standard varieties. A sett a foot long may have only two or three eyes—usually two. A sett

of D. 1135 or Q. 813 of the same length would contain a larger number of eyes, and as planting conditions have not altered in the interim, the grower is now planting far less eyes per acre than formerly. It is strongly recommended therefore that the thick P.O.J. canes be planted as close as possible in the row, when it will be found (conditions being suitable) that normal strikes are obtained.

How Frequently do Giant Toads Produce Eggs?

We have been asked repeatedly whether the toads lay but once in a year or whether they can produce eggs at more frequent intervals. In order to try and find an answer to this question numbered arm bands were placed on females which were definitely observed depositing eggs. Now, for the first time, we have a record of one of these banded females laying again. No. 1, which produced 16,000 eggs on 17th March last, was captured in the act of laying a further large batch on 30th May. Unfortunately, her egg strings were intertwined with those of eight other toads which laid on the same day, so it was impossible to determine accurately the number which this individual laid. The total number produced by the nine females on this morning was 125,000.

At least 52 toads have laid at Meringa since the 17th November, 1935, and as we have only 37 females in all, several have laid more than once.

It is of interest to record that not less than 1,560,000 eggs have been laid to date, and approximately 62,000 toadlets have been caught and distributed. Male toads are to be heard calling almost nightly in Tully and in parts of the Gordonvale area.

J.H.B.

Permits for Transfer of Sugar-Cane Plants.

In order to reduce the possibilities of carrying sugar-cane diseases from one district to another in which those particular diseases do not exist, it is necessary that strict precautions be taken in the matter of transferring cane plants from one area to another. In furtherance of this object the State of Queensland has been divided into a number of quarantine districts, and under the provisions of the Diseases in Plants Acts the transport of sugar-cane plants from one such district to any other is prohibited unless a permit has been issued by an inspector under the Acts. The boundaries between these quarantine districts consist of imaginary lines drawn east and west through Cardwell, Townsville, Bowen, Alligator Creek (south of Mackay), Rockhampton, Burrum, the southern end of Great Sandy Island, and Brisbane. Any person desirous of sending cane plants across any of the above boundaries at any time during the current season should make a request for the necessary permit to the Director, Bureau of Sugar Experiment Stations, Brisbane, before 20th July, 1935.

In addition to the above district quarantine areas, local quarantine areas are in existence in Mulgrave, Maryborough, and South Kalkie, and a permit must similarly be requested if it is desired to send plants beyond the boundaries of the quarantine areas.

Soil Erosion.

By H. W. Kerr.

DURING recent months the subject of soil erosion has been given considerable prominence in agricultural discussions. Doubtless, it is one of the most serious agricultural problems with which a country is faced, and it is of national importance. It is, at the same time, one which is conveniently ignored by those who are most adversely affected by it, and the realization of its nature is truly appreciated only when the damage has been done. As with most other problems, methods of prevention are always simpler than cures. Since the question of soil erosion is a matter of decided importance to some of our valuable cane-growing areas, it would appear fitting to place before cane farmers a few observations on—(1) its causes, (2) its prevention, and (3) its cure.

The Causes of Erosion.

The term "erosion" means the loosening and removal of soil from its previous resting place, through the agency of wind or water. Insofar as the Queensland cane areas are concerned, the action of wind is of minor importance, and we will therefore confine our attention to water erosion. When rain falls on the land surface, a proportion is absorbed by the soil, while the balance flows away and ultimately finds its way to a neighbouring watercourse. Flowing water possesses the power of carrying with it a greater or less amount of solid matter, gathered from the surface over which it flows. The gradual removal of soil in this way, insignificant though it may appear in some circumstances, is one of the most potent forces in converting valuable land—and notably land of appreciable slope—to a state of low productivity. Water which percolates through the soil carries with it valuable plantfood materials which it dissolves. To replace these, the application of simple and appropriate fertilizers is sufficient treatment. But the removal of the solid soil particles by surface "run-off" water is something which cannot be so readily restored. It is common experience that the finest particles of the soil are those most readily removed in this way, and these materials also constitute the most fertile portions of the land. When a river carrying such sediments overflows its bank, its speed is checked and the suspended matter is deposited on the flood plain in the form of sediments, which eventually provide characteristically fertile alluvial soils.

The major factors affecting the intensity of erosion are—(*a*) Type of soil, (*b*) slope of the land, (*c*) farm management methods, (*d*) amount and rate of rainfall.

(*a*) Sandy soils are, in general, least subject to erosion, since they are capable of rapid absorption of water. But should conditions result in the creation of a fully-saturated sandy soil, the absence of binding material permits it to be carried down a slope at a very rapid rate; again, the coarseness of the particles may cause it to be deposited before it has travelled any great distance.

Heavy clay soils are more subject to gradual wearing down by water, but the strong cohesive forces which exist in such soils offers great resistance to loosening.

The soils most liable to erosion are the intermediate class known as loams. When saturated with water they may move off in large masses due to their plastic nature. A loam rich in organic matter possesses advantages over those not so favoured, for this important soil constituent promotes more complete water absorption, while acting also as a mechanical obstruction due to its fibrous character. Unfortunately, few cane soils could be classed as rich in humus.

The presence of gravel and stones is sometimes helpful in preventing erosion, as they are themselves moved with difficulty; they also offer resistance to the free flow of water, and definitely protect the soil which lies beneath them.

(*b*) The steepness or "gradient" of the land has a very direct and obvious influence on the degree of erosion experienced. While silts are removed even by water flowing over relatively level land, the carrying capacity of flowing water increases at a very rapid rate with increased slope. This is very apparent when we study the rate of gully formation in a field. A series of measurements which were made to determine the influence of slope showed that, while 8,000 lb. of soil were removed annually from an acre of "level" soil, the rate of removal was doubled where the gradient was 1 per cent., and trebled where the slope was between 2 and 3 per cent. Steep slopes also affect the relative amounts of moisture absorbed and shed by the land.

(*c*) The nature of the surface of the soil is one of the greatest factors in determining the extent of erosion, and is indeed one of the major considerations in devising control measures. Soils in their natural condition possess a protective covering of forest, scrub, or natural grass, which prevents erosion on all but the steepest slopes. The removal of the vegetative cover, and particularly the subsequent tillage operations to which the land is subjected, results in a drastic disturbance of these natural conditions, and erosive factors are given full play. A loose layer of surface soil—particularly when underlain by a subsoil hardpan created by tillage implements—presents an ideal medium for the absorption of the first rains which fall, at least to the point where it becomes saturated. Should deep percolation of the excess moisture be hindered in some way, it requires little further water to cause the plastic surface layer to move down a slope, should this condition exist. The adverse influence of even surface tillage implements is readily seen on a tilled hillside field following heavy rains. The removal of the surface mulch layer reveals the tracks of the individual tynes of even the homely scarifier.

(*d*) It is readily evident that the rainfall rate is one of the potent factors in erosion. Heavy and rapid downpours inevitably cause greater removal of soil than an equal amount of rain falling over a longer period. This is due to the time factor which is involved in the moisture absorption rate for any soil, and the soil removal influence is thus bound up in the amount of run-off water. The state of the soil at the time a heavy downpour is experienced—whether it be relatively dry or already water saturated—is an important consideration. Heavy rains themselves beat and compact the surface soil layer and destroy in some degree the natural absorptive capacity of the land. In the coastal regions of Queensland, with their recurrent tropical deluges, the effects of erosion are widely evident even on relatively gentle slopes.

The character of the crop to which the land is devoted has a very marked bearing on the degree of erosion experienced. The following series of figures obtained from studies conducted in the middle west of the United States of America is very interesting in this connection:—

Soil Treatment.	Percentage of rainfall which ran off.	Total weight of soil removed per acre per year.
	Per Cent.	Tons.
Not cultivated	49	30
Ploughed 4" deep	31	36
Ploughed 8" deep	28	31
Grass sod	12	¼
Wheat each year	25	6
Maize each year	27	16

The slope of the land was slightly less than 4 per cent., and the annual rainfall varied from 24 to 50 inches over the duration of the experiment (6 years). Certain features of these results are worthy of note. Firstly, erosion was greatest on the loose, ploughed soil without crop. Secondly, the presence of a growing crop reduced the loss, and this influence was greatest with the crop which afforded the most complete cover. Maize—which might be compared with sugar-cane in this regard—reduced the erosion loss by one-half, wheat effected a reduction of five-sixths, while with grass sod an insignificant amount (¼ ton) of soil was carried away. In passing, attention should also be drawn to the loss of water due to run-off which occurred under the various systems of husbandry. The rate of soil removal on a well-tilled slope is commonly evidenced in our Queensland cane areas, when a deluge of rain is experienced during the planting season. How often the farmer awakes to find his soil and plants washed down to the low end of the block!

The Prevention of Erosion.

From the preceding discussion it may be concluded that soil erosion is caused by water running from higher to lower levels over the surface of the ground. Erosion control therefore consists in decreasing or diverting the run-off, or both. The possible methods are—

(1) Reducing the run-off by making the soil more readily absorbent.

(2) Keeping the soil covered; a good vegetative cover also slows down the run-off and causes more water to be absorbed.

(3) Holding and diverting the water along courses having such a gradient that the erosion damage is negligible. This principle is employed in terracing.

(4) Conveyance of water from higher to lower levels in artificial channels. This principle is generally applied in disposing of concentrated run-off from fields, and in checking deep gullying.

These several preventive methods will be discussed in some detail.

1. The absorptive capacity of the soil may be improved by subdrainage. The growth of deep-rooted crops—*e.g.*, lucerne—will open up stiff soils and provide channels through which the water may pass. Deep ploughing and subsoiling or grubbing will also assist in increasing absorption. In ploughing on slopes, the furrow slice should always be thrown up-hill, by the use of a reversible hillside plough. Land left in this condition will always absorb more water than where the furrow slices are thrown down-hill. Contour ploughing is obviously better than ploughing up and down the slope for similar reasons. All methods of humus restoration are to be encouraged, slow though the process may be; a soil rich in organic matter will remain open and make for more complete rainfall absorption.

2. Unfortunately, the canegrower has little opportunity for keeping his land covered. Where crop rotation is the vogue, the farmer may keep his land under grass cover for a proportion of the rotation period; and the steeper the slope of the land the greater the proportion of the rotation during which grass cover should be kept. The canegrower has, however, two opportunities of doing something in this regard; during the fallow, a green manure crop should invariably be sown; where serious erosion losses are encountered, trash should *never* be burned but left on the land surface to serve as a mulch. The benefits of trash conservation are twofold—(*a*) the avoidance of ratoon cultivation leaves the soil undisturbed and reduces the rate of subsurface packing; (*b*) excess water is shed by the trash layer instead of by the loose soil, and, therefore, a sediment-free run-off replaces the normal sediment-laden stream. On certain farms in the humid northern cane districts, this practice is being employed systematically with very good results. Relieving of the trash from the stools promotes a more rapid ratooning, and facilitates the application of both mixed fertilizer and sulphate of ammonia.

Experience shows that land of greater slope than 5 per cent. should never be devoted to cultivated crops continuously; where the slope reaches 10 per cent. cultivated crops should occupy the land only during a small fraction of the rotation period, while land of more than 15 per cent. slope should be kept in permanent pasture. From these data it is evident that much land which is being cultivated at the present time will be *completely useless* in a few years. Unfortunately, no means are available whereby the farmer may be obliged to devote his land to those crops for which it is suited, and thus avoid the national calamity of denuded hillsides of waste land.

3. Where the methods hitherto discussed are not adequate or suitable for the purpose of effecting erosion control, the farmer must resort to terracing his land. Such a suggestion is generally dismissed by the farmer as something both costly to carry out and difficult to deal with. A careful study of the accompanying notes will show, on the contrary, that terracing may be effected at very little cost, while its presence is scarcely noticed during subsequent cultural operations.

The terrace is a flat ridge of earth like a steeply-graded road or an extra large back-furrow, from 15 to 20 feet wide at the base, and built almost on contour lines around the slope. Above this ridge is a flat, broad channel. The crest of the terrace is 15 to 24 inches above the bottom of this channel. Terraces control the run-off, because they are spaced in a series like steps down the slope, each taking its share of water before the total quantity becomes large enough to do damage. The water which each traps is carried in a broad slow-moving stream to the side of the slope without damage to the field. This slow movement keeps the water in the field for a longer time, causing more of it to be absorbed into the land, and reducing run-off and loss of soil by erosion. Reference to the accompanying sketch (Fig. 12) together with a detailed description of the process of terrace construction should make these points clear.

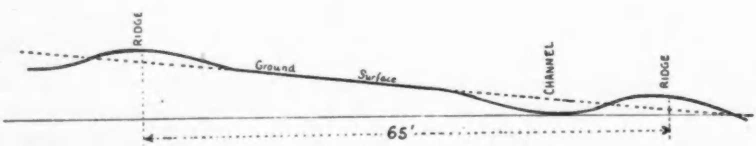

Fig. 12.—Showing the cross section of a terrace on a slope of 10 per cent. Under these conditions terraces will be formed at intervals of 65 feet down the slope.

Terraces are constructed in such a direction across the slope of the land that they provide a fall of not more than 6 inches in 100 feet. They are spaced so that each will take care of the water which falls between it and the one above; they must be close enough together so that the run-off water from average storms will not have an opportunity to descend in small rivulets between the terraces. Where the slope is slight, practically all sediment carried to the terrace under abnormal conditions will be deposited immediately. The most suitable distance between terraces is governed by the slope of the land and the soil type. As a rule, there should be a vertical fall of from 4 to 6 feet between terraces on land with a grade of from 5 to 10 per cent. A greater vertical distance should be allowed where the slope is greater.

The most suitable distance between terraces is shown in the following table:—

Slope of Land.	Vertical Drop between Terraces.		Distance between Terraces along Slope.
Per cent.	Feet	inches.	Feet.
3	3	0	100
5	4	3	86
8	6	3	78
12	7	0	58

The gradient along the terrace is also governed by the length of the terrace and the natural slope of the land; the following table offers a useful guide in this respect:—

Length of Terrace.	Gradient per 100 feet along Terrace where Land Slope is.		
	5 Per Cent.	10 Per Cent.	15 Per Cent.
Feet.	Inches.	Inches.	Inches.
0 to 300	½	¾	1
300 to 600	1	1½	2
600 to 900	2	3	4
900 to 1,200	4	6	7
1,200 to 1,500	6	..	..

In staking out the terraces a home-made level is useful (Fig. 13). It is constructed in such a way that one leg is shortened or made adjustable, so that the correct fall is obtained when in the "level" position, as shown by the bob or spirit level. Thus if the span be made 16 feet 8 inches six steps will be required per 100 feet of terrace; hence, to strike a fall of 6 inches in 100 feet, one leg should be made 1 inch shorter than the other.

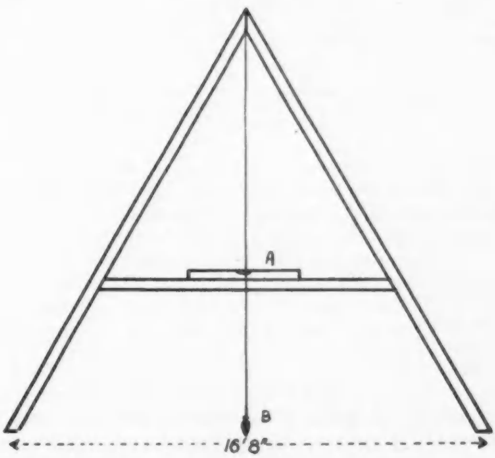

FIG. 13.—Illustrating the home-made leveller for use in laying out terraces. Either spirit level (A) or bob (B) may be used.

The first step in the construction of the terraces is to find a suitable outlet for the water which will be discharged at either end of the terrace. A well-sodded pasture is best. Care should be taken that any gully into which the water is discharged is protected against erosion,

using saplings or rocks where necessary (Fig. 14), while at times earth dams may be necessary. The point at which a terrace crosses an intermediate small gully must be higher and stronger than at other points to eliminate the danger of the water breaking through. The top terrace is made first, and should be built up sufficiently high, so that water from higher up will not collect and break across it before it has settled. An ordinary swing plough may be used to mark out the line of stakes on the terrace; the stakes may then be used in setting out the next one below. It is important to exercise care in laying out the terraces accurately.

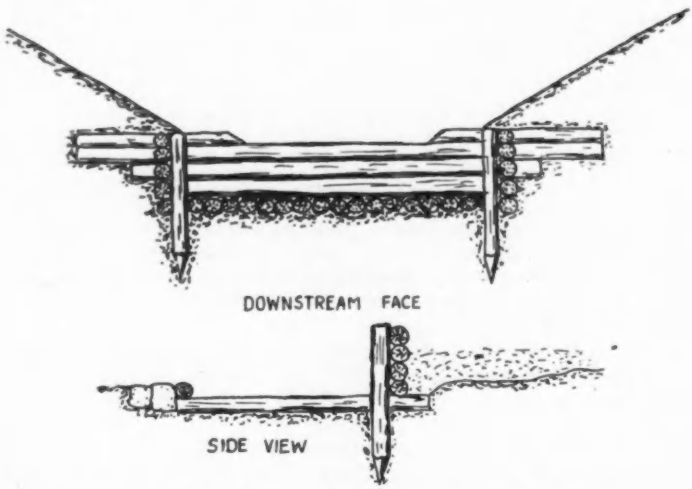

FIG. 14.—A suitable type of log dam which may be built across a gully. The apron of timber effectively prevents erosion by the falling water.

The terrace is built up first by means of a team and plough, and later by the use of a light road grader or V-shaped drag. Very little ploughing is necessary in light soils. It is customary to throw together six or eight furrows, and then push the soil towards the centre by means of the grader. This process is continued until the top of the terrace is 12-18 inches higher than the lowest point above the terrace—that is, in the water channel. When completed the terrace should be fairly compacted, and no low points should be left. It is important to build sufficiently highly over low places or small gullies.

During subsequent ploughing and planting operations, the contours should be followed; if the slope is less than 8 per cent., and the terraces are well established, they may be ignored in all cultural operations. When crossing the terrace it is an advantage to plough slightly shallower so that the bank is not weakened early in its lifetime. It is advisable to pay careful attention to the terraces during their first year, so that any break may be repaired as it forms. It is best to throw a little soil on to the terrace when ploughing, and the channel on the upper side of the ridge must be kept clear. For safety sake, the land should first be devoted to grass or to a cover crop of peas or beans to give it the best opportunity to consolidate.

Although terracing has not been exploited in the Queensland cane areas, it is a practice worthy of the closest consideration by growers who are farming high slopes. The cost of the work in the American states is about 10s. per acre, which is certainly not excessive. The farmer should take care that the work is carried out after the risk of heavy rains is past—that is, during the autumn or winter months. The terraces will then have an opportunity of settling down by the late spring, when a cover crop of legumes may be planted to protect the terrace during its first wet season.

Cure of Erosion Damage.

From what has been said it will be apparent that the direct cause of destructive erosion is, on the one hand, soil disturbance, which destroys the binding forces operating under natural conditions, and on the other hand, the force of running water tending to move it. Removal of natural vegetation also tends to increase the quantity of run-off. The formation of gullies may usually be traced to the creation of a direct fall for run-off concentrated at that point. Gully-cutting must be checked by decreasing the fall and cutting power of the water until it becomes negligible. This may be done by diverting the water to a fresh channel, by providing an artificial channel at the fall, or by raising the level of the gully floor by means of soil-saving dams. This reclamation work should commence at the head of the gully, while the lower part can later be reclaimed by additional dams, if the value of the land warrants the cost.

The general removal of soil over a wide expanse of field (sheet erosion) or shallow gullying of fields is primarily the form of erosion attending any form of cultivation. Cultivation removes the roots which naturally bind the soil together, by turning under the layer of surface organic matter which helps markedly in increasing the absorptive power of the soil, by destroying the soil humus through continuous cropping and exposure, and by making the soil loose and friable. The lastnamed also assists in water absorption, but when water begins to run off it hastens the removal of the soil.

The surest method of preventing erosion is to keep the soil continuously covered with vegetation. For steep slopes and poor rocky soils, forest growth is the best and safest plan. For better soils, capable of producing good yields, permanent grass is recommended for moderate slopes with but intermittent planting of cultivated crops. Fertilization of such pastures will assure more luxuriant growth of grass, and hasten the rate of fertility restoration.

Finally, many soil erosion problems are not individual but community concerns, which can only be tackled and solved through the concerted effort of all concerned. This must usually be achieved through the intervention of an independent authority; this course must inevitably follow the full realisation of the seriousness of soil erosion from the national standpoint.

Are Our Seasons Changing?

By N. J. KING.

THE above question, frequently discussed amongst growers and others, influenced the writer to enquire into records for the Bundaberg area, with a view to finding an answer. Much of the credit for the large crops cut off the Woongarra and other soils in the early years of cane-farming is given to the favourable rainfall conditions then allegedly existing in the district.

It was found that rainfall figures from January, 1883, were available, and these are given in monthly precipitations from that date to December, 1935.

RAINFALL AT BUNDABERG POST OFFICE.

Year.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Total.
1883	752	461	126	128	307	0	29	109	30	352	24	191	2,509
1884	317	553	502	182	492	161	201	9	12	124	1,048	230	3,831
1885	237	288	343	46	194	595	4	38	515	48	119	490	2,917
1886	690	608	101	271	211	682	381	181	401	300	493	1,084	5,393
1887	706	1,152	1,336	674	42	29	527	512	440	64	611	371	6,464
1888	184	1,965	36	139	89	133	0	50	13	141	194	516	3,460
1889	77	224	783	891	398	58	757	247	179	76	545	561	4,796
1890	797	468	1,398	263	447	188	190	45	181	123	250	372	4,722
1891	774	72	249	389	367	1,331	152	297	126	217	311	795	5,080
1892	727	11	1,259	344	488	206	82	160	45	690	150	1,353	5,515
1893	2,270	3,210	965	223	207	1,479	186	420	52	89	156	31	9,288
1894	1,992	271	948	403	505	434	0	37	201	227	162	348	5,528
1895	2,280	731	79	459	150	1	204	10	304	174	265	1,106	5,770
1896	603	2,516	108	76	231	112	74	103	10	53	416	220	4,522
1897	547	343	392	30	248	174	792	51	333	464	111	588	4,073
1898	2,754	941	2,044	39	204	198	16	413	276	181	270	344	7,680
1899	1,131	726	376	413	292	142	233	262	167	160	6	762	4,670
1900	463	86	186	115	397	146	520	114	156	305	106	128	2,722
1901	234	261	317	1,027	114	74	201	559	180	218	128	0	3,313
1902	633	75	199	43	2	0	7	13	31	124	65	138	1,330
1903	97	260	605	38	1,155	33	598	88	355	43	325	997	4,594
1904	318	85	426	564	132	86	51	62	48	332	16	516	2,636
1905	1,667	217	335	631	426	110	71	17	95	237	95	674	4,575
1906	692	992	190	117	844	201	3	186	1,090	157	97	385	4,954
1907	329	390	1,281	38	308	449	87	43	0	170	290	299	3,684
1908	477	438	576	413	67	36	71	156	110	239	73	334	2,990
1909	652	370	506	154	67	151	565	166	98	41	355	299	3,424
1910	1,181	243	920	31	19	617	210	16	233	70	821	158	4,519
1911	2,105	975	431	246	56	0	37	115	0	236	130	298	4,629
1912	396	247	651	0	133	1,023	175	78	22	474	314	101	3,614
1913	4,575	429	673	501	531	345	126	2	152	18	183	522	8,057
1914	139	340	560	255	96	289	62	36	84	636	53	213	2,763
1915	386	1,281	7	44	182	58	103	131	28	80	108	312	2,720
1916	130	507	326	396	145	333	215	236	423	581	617	663	4,572
1917	907	846	1,071	199	184	4	22	114	354	239	648	302	4,888
1918	1,790	562	308	481	101	2	40	122	47	4	146	138	3,741
1919	16	322	537	153	655	13	0	48	0	228	63	5	2,038
1920	1,147	32	171	153	301	267	190	45	194	329	217	1,056	4,205
1921	741	72	338	881	204	448	288	885	35	80	168	1,614	4,954
1922	754	960	107	50	51	157	333	110	52	80	17	479	3,150
1923	822	48	48	660	0	410	90	80	180	34	134	378	2,884
1924	148	985	784	137	32	79	363	50	203	175	403	362	3,721
1925	1,366	596	570	56	59	792	45	102	57	61	129	645	4,478
1926	290	141	284	76	995	117	18	0	87	74	13	1,696	3,791
1927	2,580	530	926	383	18	326	106	122	100	301	528	584	6,604
1928	277	1,318	93	1,354	86	525	96	25	15	45	149	119	4,102
1929	421	1,073	249	725	31	336	4	39	18	239	238	624	3,997
1930	1,592	500	177	98	337	876	132	264	154	197	57	225	4,609
1931	279	2,377	691	134	439	117	64	90	83	147	349	944	5,714
1932	52	61	12	215	209	28	49	23	98	623	56	268	1,694
*1933	893	411	68	784	83	218	460	139	97	602	647	1,098	5,500
*1934	241	2,109	228	1,175	108	223	157	115	64	289	893	488	6,090
*1935	330	534	124	629	254	74	529	61	285	165	2	926	3,913

* Rainfall at Sugar Experiment Station.

In considering these records it is noticed that if the total annual rainfall be averaged for each five years from 1883 to 1932 the following figures are obtained:—

Period.	inches.	Period.	inches.
1883–1887	42.21	1908–1912	38.35
1888–1892	47.15	1913–1917	46.00
1893–1897	58.16	1918–1922	36.18
1898–1902	39.43	1923–1927	42.96
1903–1907	40.89	1928–1932	40.23

The 1893 to 1897 period is abnormal on account of the 1893 flood year, when the rainfall totalled 92·88 inches. Similarly, if we take each ten-year period and separate the very dry from the very wet years, we arrive at the following:—

Period.	No. of Years under 30 inches rain.	No. of Years over 60 inches rain.
1883–1892	2	1
1893–1902	2	2
1903–1912	2	0
1913–1922	3	1
1923–1932	2	1

It must be obvious from these authentic records that the seasons have not changed radically since 1883. Reference to the table will show that the monthly incidence of rainfall is also much the same now as fifty years ago.

We are frequently reminded of the large crops then harvested as compared with the present-day production. An endeavour was made to obtain figures of cane tonnage per acre for the earlier years, but lack of records defeated this effort, and comparison with present-day acreage returns is therefore not possible. Some records for the whole of the sugar-producing area of the State are, however, obtainable since 1900, and these are shown in the accompanying graph (Fig. 15).

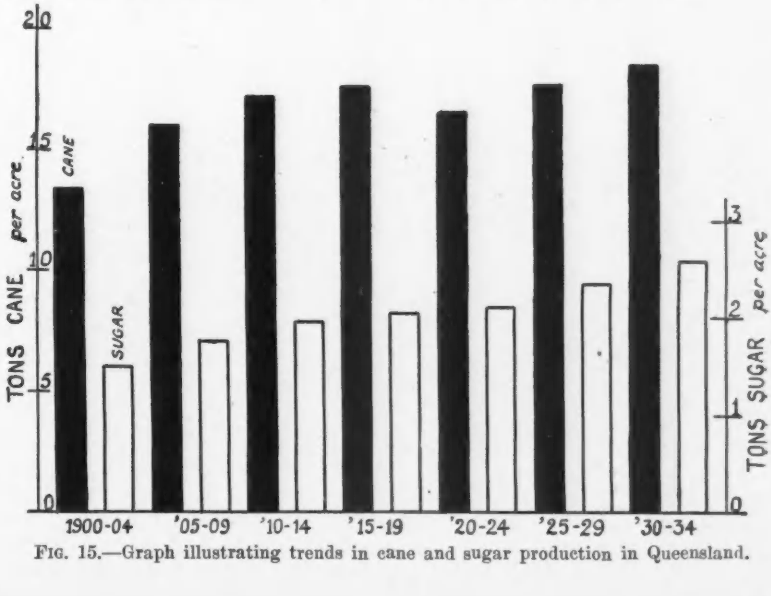

FIG. 15.—Graph illustrating trends in cane and sugar production in Queensland.

This exhibits a definite upward trend of cane per acre since 1900. In seeking an explanation of the reputed large yields one can only conclude that during the first two or three years of cane-growing on new land occasional very large crops were harvested, but the reduction in crop returns must have been very marked after that period. Artificial fertilizers were not then used, and soil depletion would advance at a very rapid rate. What, then, was the reason for this decline in crop returns if seasons have not changed? It should not be forgotten that other major factors besides climatic ones were operating at that time. Firstly, the virgin nature of the soil with its ideal physical condition to a depth of many feet; secondly, the richness and fertility of that same soil after centuries of luxurious scrub growth, and the ultimate burning-off of the felled timber; thirdly, the natural subsoiling through the medium of the tree roots. The absence of implements in the early days kept the original soil under ideal conditions of tilth, and this condition existed for some years after farming began. It must also be remembered that mechanical planting was unknown as a farm practice, mechanical cultivation was not used, and the entire farm routine involved the use of far less implements than are utilized in recent times. All of these factors continued to keep the soil in a better state of tilth than exists at present; less soil packing then developed from implements, and plough and cultivation pans must have been virtually unknown.

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